

REMARKS

Claims 1–20 are pending in the present application.

Claims 1–7 have been withdrawn.

Reconsideration of the claims is respectfully requested.

35 U.S.C. § 102 (Anticipation)

Claims 8 and 10–14 were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,060,787 to *Zhao et al.* Claims 8–12, 14 and 16–19 were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,054,383 to *Suzuki et al.* These rejections are respectfully traversed.

A claim is anticipated only if each and every element is found, either expressly or inherently described, in a single prior art reference. The identical invention must be shown in as complete detail as is contained in the claim. MPEP § 2131 at p. 2100-76 (8th ed. rev. 3 August 2005).

With respect to the rejection over *Zhao et al.*, independent claims 8 and 16 each recite a protective barrier layer comprising a material for which removal by chemical mechanical polishing is primarily mechanical. Such a feature is not found in the cited reference. The third protective layer 307 in *Zhao et al.* that is cited in the Office Action as satisfying this limitation is actually a CVD tungsten layer.

The Office Action states:

The barrier layer comprises a material for which removal by chemical mechanical polishing is primarily mechanical because the tungsten barrier layer (307) resists attack by the polishing slurry (col. 6, lines 3–19).

Paper No. 20050901, page 2. However, the cited portion of *Zhao et al* reads:

As with conventional tungsten layers, CVD deposition is substantially conformal. Therefore, a deposition trench 312, which follows the contours of the original alignment mark trench 300, remains in the surface of the wafer 310 following tungsten deposition. However, whereas conventionally the walls of the deposition trench are formed from bulk tungsten, in this embodiment of the present invention the walls 314 are formed from the protective third tungsten layer 307 which covers the bulk layer 306. As in the conventional case, the deposition trench 312 ultimately serves as an alignment mark. However, the fine grain size and equiaxed grain structure of this nucleation layer 307 make it more resistant and more uniform in response to slurry attack than the underlying bulk tungsten layer 306. As a result, the deposition trench 312 remains a consistent and reliable alignment mark.

Zhao et al, column 6, lines 3–19. The cited portion of *Zhao et al* contains no teaching that removal of tungsten layer 307 by CMP is primarily mechanical. *Zhao et al* merely teaches that when layer 307 is formed by nucleation, the fine grain size and equiaxed grain structure makes the tungsten more resistant to slurry attack, without specifying (a) whether the increase in resistance observed is increased resistance to chemical removal or to mechanical removal, or (b) whether the increased resistance causes removal by CMP to become a result primarily from chemical etching (removal) rather than abrasion (mechanical removal). The cited portion of *Zhao et al* thus contains no support for the inference drawn in the Office Action.

The Office Action further states:

Although Zhao does not specifically call the protective layer (307) a barrier layer, however tungsten is well known to provide the barrier function according to the teachings of Horak et al. (Col. 5, lines 34–52).

Paper No. 20050901, page 2. However, the cited portion of U.S. Patent No. 6,436,814 to *Horak et al* reads:

Additionally and shown in FIGS. 5 and 9, conductor 501 could include conformal conductor liner 510 and conformal conductor 520. Conformal conductor liner 510 would be the protective barrier lining the sidewalls of opening 340 and recess 330, and would be between conformal conductor 520 and insulator 310. For example, if conformal conductor 520 was CVD tungsten, conformal conductor liner 510 would prohibit the very aggressive oxidizing chemistry of CVD tungsten from affecting insulator 310 or any other underlying materials. Additionally, because conformal conductor liner 510 and conformal conductor 520 are preferably conformal conductive materials, they are easily capable of filling high aspect ratio structures, recursive structures, and the like. Thus, materials capable of being conformal conductor liner 510 and conformal conductor 520 include tantalum nitride/tantalum, tantalum/tantalum nitride, tantalum/copper, tantalum nitride/copper, tungsten nitride/tungsten, tungsten/tungsten nitride, titanium nitride/titanium, and titanium/titanium nitride.

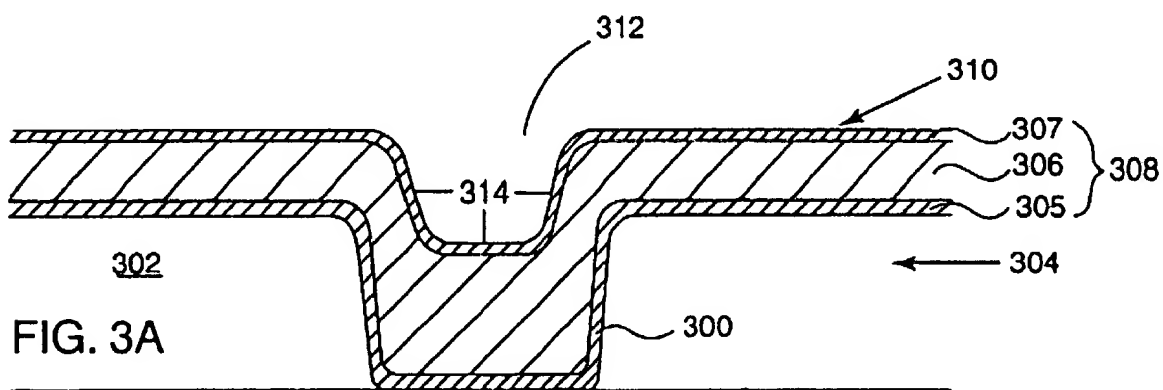
Horak et al, column 5, lines 34–52. *Horak et al* actually teaches that tungsten is a material for which a protective or barrier layer is required, NOT a material that provides a barrier function. While *Horak et al* suggests that conductor liner 510 might be tungsten, that suggestion is (a) inconsistent with the affirmative teaching that tungsten is a material requiring a barrier layer, and (b) made as part of multiple assertions that materials are interchangeable (tantalum nitride/tantalum and tantalum/tantalum nitride; tungsten nitride/tungsten and tungsten/tungsten nitride; titanium nitride/titanium and titanium/titanium nitride), an obvious attempt to simply describe all possible permutations without regard to whether a particular combination of materials is actually functional.

Still further, the specification and claims make clear that the recited protective barrier layer serves as a barrier to etching. *Horak et al* teaches that the “barrier function” of conductor liner 510 is one against oxidation, not against chemical etching and/or removal by abrasion. Accordingly, *Horak et al* does NOT teach that tungsten is a barrier material, as that term is employed in the specification and claims, as suggested in the Office Action.

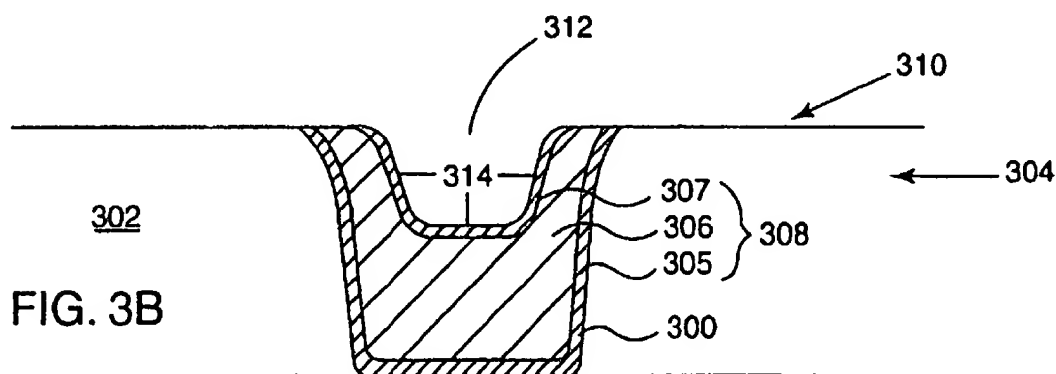
With respect to the rejections over *Zhao et al* and *Suzuki*, independent claims 8 and 16 each recite that the tungsten layer underlying the protective barrier layer fills the opening within the dielectric layer. Such a feature is not found in the cited references. The Office Action states:

As seen in figure 3A of Zhao, the conformal tungsten layer (306) fills the opening of the dielectric layer (302). As seen in figure 2D, the conformal tungsten layer (8) fills openings within the dielectric (4).

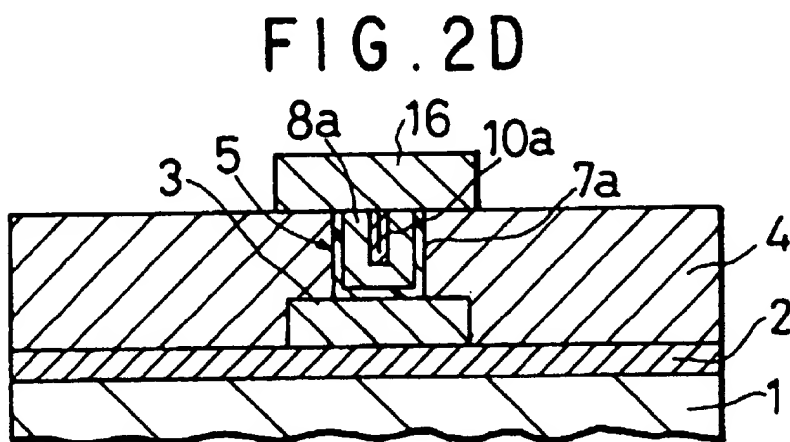
Paper No. 20050901, page 7. However, *Zhao et al* depicts the upper surface of conformal layer 306 and being below the upper surface of dielectric layer 302 through which the opening is formed:



Zhao et al, Figure 3A. The relative positions of the upper surfaces of conformal layer 306 and the upper surface of the dielectric layer 302 in *Zhao et al* is even more apparent from Figure 3B, which depicts the structure after chemical mechanical polishing:



Zhao et al, Figure 3B. Similarly, tungsten 8a in Figure 2D of *Suzuki et al* does not fill the opening in insulator 4:



Suzuki et al, Figure 2D. To the extent that the Examiner interprets “filling” as requiring only covering a width of the opening, such an interpretation is arbitrary and capricious. Water within a half-filled glass extends across a width of the glass, but nonetheless does NOT fill the glass.

Therefore, the rejection of claims 8–14 and 16–19 under 35 U.S.C. § 102 has been overcome.

35 U.S.C. § 103 (Obviousness)

Claim 9 was rejected under 35 U.S.C. § 103(a) as being unpatentable over *Zhao et al* in view of *Horak et al*. Claim 15 was rejected under 35 U.S.C. § 103(a) as being unpatentable over *Zhao et al* in view of U.S. Patent No. 6,346,741 to *Van Buskirk et al*. Claims 13, 15 and 20 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *Suzuki et al* in view of *Van Buskirk et al*. These rejections are respectfully traversed.

As noted above, independent claims 8 and 16, from which rejected claims 9, 13, 15 and 20 depend, each recite that the conformal tungsten layer underlying the protective barrier layer fills the opening within the dielectric layer. Such a feature is not found in the cited references. As previously noted, such a feature is not shown or described in *Zhao et al* or *Suzuki et al*. Similarly, neither *Horak et al* nor *Van Buskirk et al* depict a conformal tungsten layer filling an opening through a dielectric layer.

Therefore, the rejection of claims 9, 13, 15 and 20 under 35 U.S.C. § 103 has been overcome.

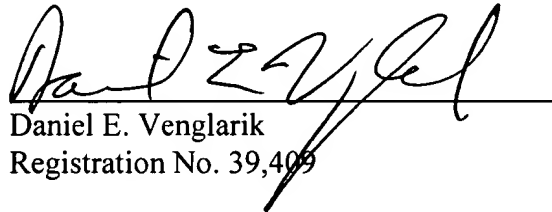
If any issues arise, or if the Examiner has any suggestions for expediting allowance of this Application, the Applicant respectfully invites the Examiner to contact the undersigned at the telephone number indicated below or at *dvenglarik@davismunck.com*.

The Commissioner is hereby authorized to charge any additional fees connected with this communication or credit any overpayment to Deposit Account No. 50-0208.

Respectfully submitted,

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